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THE EVALUATION OF INTERNATIONAL LATEX CORPORATION SWIM SUIT HELMET AND FACEPIECE

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Navy Experimental Diving Unit
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13. ABSTRACT

An evaluation of a hard shell swimmers' helmet developed under BuShips contracts NObs 72125 and 72438 was made to determine its suitability for use by Navy swimmers or divers. The helmet was found to be satisfactory in basic design. Recommendations for further development are made.

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EVALUATION REPORT 17-59

INTERIM REPORT ON THE EVALUATION OF INTERNATIONAL LATEX CORP SWIM SUIT HELMET AND FACEPIECE; PHASE 2

PROJECT NS 185-005 SUBTASK 4 TEST 43

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15 APRIL 1959

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SUMMARY

PROBLEM

Determine the suitability of a hard shell swimmers helmet for use by Navy swimmers or divers. Specific features to be evaluated are as follows:

(a) Compatability with standard swim suit

(b) Suitability for use with communications

(c) Fit, comfort, and other features which affect the use of the helmet

(d) Safety

(e) Visibility

FINDINGS

The following findings were made:

(a) The hard shell is basically satisfactory

(b) The method of fastening the helmet to the suit is not satisfactory

(c) The facepiece is subject to fogging

(d) The method of positioning the helmet on the head is satisfactory

(e) The fit and positioning of the oral nasal mask is unsatisfactory

(f) The breathing resistance is low

(g) The buoyancy is satisfactory

(h) The torque characteristics are not satisfactory

(i) The materials of the helmet are subject to corrosion

(j) The helmet cannot be ditched in an emergency

(k) The dump valve is unsatisfactory

(l) The helmet is suitable for use with communications

RECOMMENDATIONS

It is recommended that the features found to be unsatisfactory be improved in further development, while retaining the satisfactory features.

ADMINISTRATIVE INFORMATION

Ref: (a) BuShips contract NObs 72125 dated 4 April 1956
(b) BuShips ltr ser 538-964 dtd 22 April 1957
(c) EDU Report ER 14-57, Evaluation of International Latex Corporation Swim Suit Helmet and Facepiece; Phase 1, C. M. Prickett, 15 March 1957
(d) BuShips contract NObs 72458, dated 27 June 1958
(e) Telcon W. F. Searle, EDU, to M. J. Foran, BuShips Code 638, 27 Feb 1957

By reference (a), the Bureau of Ships contracted for the development of a swim suit helmet and facepiece. Two separate phases were included in the contract as follows:

Phase 1 - Design, develop and furnish a facepiece for a swim suit.
Phase 2 - Design, develop and furnish a hard head-shell, compatible with the facepiece developed under phase 1.

Reference (b) stated that phase 1 was satisfactorily completed, and authorized the contractor to proceed with phase 2. Reference (c) is the report of the evaluation of the facepiece developed under phase 1.

By reference (d), the Bureau of Ships contracted for the redesign and modification of the hard head-shell helmet developed under reference (a).

Numerous progress conferences attended by representatives from the Bureau of Ships, the Experimental Diving Unit, and the International Latex Corp., have been held throughout the development of the swimmers helmet.

By reference (e), project number NS 185-005 Subtask 4 Test 43 was assigned. C. M. Prickett, GM1, USN was assigned as project engineer and LTJG G. M. Janney, USNR was assigned as project officer. Work commenced on Phase 2 on 22 April 1957. The following breakdown indicates the manhours expended for this evaluation:

DESCRIPTION	MANHOURS
Subjective evaluations	75
Progress conferences	30
Photography	2
Report preparation	40
Report typing & duplication	20
TOTAL	167

Charges incurred were lodged against project orders 16102/58 and 16102/59.

This is the second report under this project number. It is anticipated that an additional report will be issued, covering any further development of the hard head-shell helmet and facepiece. The report is issued in the Experimental Diving Unit's Evaluation Report series and is distributed only to the Bureau of Ships.

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1. INTRODUCTION

1.1 Background

1.1.1 There is a need for an improved helmet for swimmers and divers which would provide better visibility, communications, and blast protection. The requirements for pilots headgear are similar in many respects to the requirements for an underwater helmet. Both should provide protection, communications, good visibility, comfort and incorporate a breathing system.

1.1.2 A suitable facepiece for such an underwater helmet was developed under phase 1 of NObs 72125 by The International Latex Corp. (The manufacturer has had considerable experience in developing aviation helmets.)

1.1.3 A hard shell helmet was developed as phase 2 of NObs 72125 and modified according to the specification of NObs 72458.

1.1.4 The second phase of contract NObs 72125 specifies in part that the contractor shall "Design, develop, and furnish a hard head-shell, compatible with the facepiece developed under phase 1."

Contract NObs 72458 specifies in part that the contractor shall "Redesign and modify government-furnished hard head-shell helmet developed under contract NObs 72125".

The primary objectives of the redesign was to.

(a) Reduce breathing resistance
(b) Investigate the use of Teflon coating to reduce fogging
(c) Install a hydraulic liner
(d) Install a liner of lead
(e) Install communication equipment

1.2 Objective

1.2.1 The objective of the second phase of this project is the evaluation of the hard shell helmet to determine its suitability for underwater use by divers and swimmers. Specific features are to be studied in particular as follows:

(a) Compatibility with standard swim suit
(b) Suitability for use with communication
(c) Fit, comfort, and other features which affect the use of the helmet by a swimmer or diver.
(d) Safety
(e) Visibility in actual use (The visual field and distortion have been reported in EDU Report ER 14-57, Evaluation of International Latex Corporation Swim Suit Helmet and Facepiece; Phase 1, C. M. PRICKETT, 15 March 1957.

1.2.2 A second objective is to aid in the development of such a suitable helmet by providing technical advice to the contractor during the development of the helmet.

1.3 Scope

1.3.1 The scope of this project is limited to an interim evaluation, since it is anticipated that further developmental work will be performed, based on the findings of this evaluation.

1.3.2 The evaluation is limited to a subjective evaluation by experienced divers and swimmers at the Experimental Diving Unit.

1.3.3 The assistance to the contractor is limited to technical advice concerning the problems encountered in Diving and Underwater swimming and the provision of depth test facilities.

2. DESCRIPTION

2.1 General

2.1.1 The helmet developed for underwater use by the International Latex Corp. is shown in figures 1 and 2 being worn by a diver. A standard swim suit is attached to the helmet and an open circuit SCUBA is attached to provide underwater breathing capabilities. A few minor modifications have been made in weight distribution of the helmet since the photographs were taken; however, the appearance remains essentially the same.

2.1.2 The helmet consists of a hard outer shell, a hinged facepiece, an inner, oral-nasal mask, breathing ducts, lead weights, water bags for positioning the head, communications fitting, surface breather, dump valve, microphone and ear phones.

2.1.3 The helmet was designed to fit the medium head, or half the population.

2.2 Hard Shell

2.2.1 The outer shell is constructed of molded reinforced polyester resin. Breathing ducts and openings for the facepiece, surface breather, and dump valve are provided in the shell. A rubber gasket is cemented around the opening for the facepiece to make a water tight seal. A channeled aluminum ring is fastened around the neck opening of the helmet to make a seal with the neck of a modified rubber swim suit.

2.2.2 A liner of lead weights is attached to the inside of the helmet to counteract the buoyancy of the helmet.

2.2.3 A system of four water bags is attached inside the helmet by metal snaps. There is a bag at the back, one on each side, and one on the top of the helmet. The purpose of these bags is to position the head firmly in the helmet. The bags are inflated with water instead of air to counteract the buoyancy of helmet. A separate fitting for each bag extends through the hard shell of the helmet. A small pump is provided to inflate the bags.

2.2.4 The dump valve is a spring loaded valve intended to be used to eject water from the helmet. A button is provided to open the valve when necessary.

2.2.5 The surface breather is a duct leading from the oral nasal mask to the outside of the mask. It is sealed by a cap with interrupted threads. The cap is attached to the helmet by a chain to prevent loss of the cap.

2.3 Breathing System

2.3.1 An oral-nasal mask is installed in the helmet close to the facepiece. The purpose of this mask is to seal off the mouth and nose from the rest of the mask, thereby reducing dead space and also fogging of the facepiece. The oral-nasal mask is attached to a frame which can be moved fore and aft to provide some adjustment for head size.

2.3.2 The breathing ducts of the helmet lead directly into the oral-nasal mask to provide separate inhalation and exhalation passage for the breathing gas. The surface breather described above also opens into the oral-nasal mask. The breathing tubes of most types of SCUBA equipment can be attached to the exterior outlets of the breathing ducts.

2.4 Neck Seal

2.4.1 The upper portion of a rubber swim suit has been modified to be compatible with the helmet. A rubber ring is attached to the neck of the suit. This ring is inserted into the aluminum channel at the bottom of the helmet (described above). An aluminum locking ring is then placed over this rubber ring to lock it into place.

2.4.2 The neck of the suit contains a rubber neck seal to prevent air from flowing from the helmet into the suit. Laces have also been added to the neck to aid the neck seal and keep the suit snug at the neck.

2.5 Face Piece

2.5.1 The face piece is similar to the one described and evaluated in reference (e). A heavy brass frame has been added to increase rigidity and effect a better seal. The frame is attached to the helmet by hinges at the top and it is secured at the bottom by means of a spring loaded catch. A locking device at the hinges prevents the face piece from falling closed accidentally.

2.6 Communications

2.6.1 A small aviation-type microphone is installed in the oral-nasal mask and earphones are installed in the helmet next to the wearer's ear. The outlet for the microphone and earphones is located on the right side of the helmet.

2.6.2 A water proof cannon plug provides the necessary electrical entrance into the helmet.

2.6.3 A small transistor amplifier speaker system has been provided by the contractor. Communications are maintained by means of a water proof cable. The system is battery operated.

3. PROCEDURE

3.1 Subjective Evaluation

3.1.1 The procedure followed at EDU in the development and evaluation of the helmet consisted of donning the suit and helmet and submerging in the wet tank. The various possible positions such as head up, head down, swimming position, face up, and on the sides, were tried. The subjects then made comments on the pertinent features of the helmet. These comments include the following:

(a) Comfort
(b) Fit
(c) Buoyancy
(d) Torque
(e) Visibility
(f) Communications
(g) Leakage (if any)
(h) Ease of putting on and technique of adjustment

3.1.2 A limited number of these subjective dives were made to depths of 100 feet of sea water in the wet pressure tank.

3.1.3 A total of seven experienced swimmers and/or divers from the Experimental Diving Unit used the helmet for these tests.

3.1.4 Throughout the course of the development of the helmet, periodic progress conferences were held to provide engineering and operational considerations by qualified, experienced officers and men from the Experimental Diving Unit, Bureau of Ships, Underwater Demolition Team 21, and the Navy Underwater Sound Laboratory.

4. RESULTS AND DISCUSSION

4.1 Hard Shell

4.1.1 The basic design and construction of the hard shell of the helmet appears to be satisfactory. No tests were made to determine the strength of the helmet. As a result of rough handling, one of the breathing ducts was broken loose from the shell where it was cemented on.

4.1.2 The shell was designed to fit the medium head, which restricts its use, therefore, to about one-half the population. With the addition of the head lining and the hydraulic bladders, it is likely that the effective helmet size is now smaller than required to fit the medium head.

4.1.3 The neck seal is difficult to effect. The aluminum channel at the bottom of the helmet and the locking ring are flimsy. Both were bent as a result of rough handling.

4.1.4 The dump valve located near the chin on the helmet does not function properly. Water enters the helmet when the button is depressed, and it is impossible to expel water from the helmet by means of this dump valve.

4.1.5 The helmet is heavy due to the necessity of overcoming the buoyancy. The total weight of the helmet is approximately 18 pounds in air.

4.2 Face Piece

4.2.1 The facepiece provides good visibility without excessive distortion, when it is clear of moisture. However, there is a definite problem of preventing moisture (fog) from condensing on the inside of the face piece or of removing the moisture.

4.2.2 The locking device which holds the face piece open is subject to failure from corrosion.

4.2.3 The latch which holds the face piece closed does not ensure positive closure.

4.2.4 The brass frame around the face piece is rugged and holds its shape well. No problem in sealing the face piece against leakage has been experienced since the present, heavy frame was installed.

4.3 Fit and Positioning

4.3.1 The four hydraulic bladders provide adequate means of positioning and holding the helmet on the head. However, filling and emptying the four bags takes considerable time.

4.3.2 The fit of the oral-nasal mask is unsatisfactory as it is installed in the helmet. The oral-nasal mask extends too high, blocking vision and causing discomfort.

4.3.3 The stiffener on the oral-nasal mask is improperly shaped and/or positioned with the result that pressure is exerted against the bridge of the nose, causing discomfort.

4.4 Breathing Characteristics

4.4.1 The breathing resistance of the helmet when used with an open circuit demand regulator is not noticeably higher than the resistance of a mask or mouthpiece type of demand system. Mechanical respirator tests have not been conducted.

4.4.2 The oral-nasal mask does not always make an adequate seal. This may be due to the improper fit or positioning of the oral-nasal mask which was mentioned above.

4.4.3 The surface breather is adequate. However, care must be exercised to ensure that a good seal is made when the cover is replaced.

4.5 Buoyancy and Torque

4.5.1 With the lead lining of approx 12 pounds, the buoyancy of the helmet is nearly neutral.

4.5.2 Too much of the ballast is located near the top of the helmet, with the result that a torque exists when the wearer is lying on his back. This torque tends to twist the helmet down at the top, shoving the oral-nasal mask into the wearer's eyes.

4.6 Communications

4.6.1 The microphone and earphones as installed provide good communications. The location and size of the spaces made available for these components is adequate.

4.6.2 The water proof plug provides a satisfactory means of transmitting the electrical signals through the shell of the helmet.

4.6.3 No extensive tests of the communications were made since the microphone and ear phones were added only to demonstrate the compatibility of using a communications system with the helmet. However, the communication system provided has been quite satisfactory, even to depths of 100 ft.

4.7 Neck Seal

4.7.1 The method of fastening the suit to the helmet is not optimal. As noted above, the locking ring and the channel are too flimsy. The seal is very difficult to effect.

4.7.2 The inner seal of the suit is effective except when the wearer is head down and there is leakage past the oral-nasal mask. At such a condition, air escapes past the neck seal and inflates the suit.

4.7.3 The method of lacing up the neck to eliminate a non-rigid dead air space is adequate. However, the neck opening is too small making donning and removing the suit difficult and painful. The neck opening could be made considerably larger, since the laces would eliminate any sloppiness of fit.

4.8. Emergency Ditching

4.8.1 It is highly unlikely that the helmet could be ditched in an emergency situation. The hydraulic bags are too difficult to empty and they empty so slowly that, except in the case of a diver with a very small head size, the helmet could not be removed by the diver in less than several minutes.

4.8.2 There is a definite need for ditching the helmet in case of a failure of the breathing system or flooding of the helmet is primarily due to the weight of the helmet. If the helmet were flooded, it would be approximately 18 pounds negatively buoyant. This weight would make it extremely difficult for a man to swim on the surface, especially since the weight is located at his head.

4.8.3 It is realized, however, that it may not be possible to provide emergency ditching capabilities for this helmet without losing many of the advantageous features of the present helmet. Nevertheless, an investigation of this problem should be made.

4.9 Corrosion

4.9.1 Corrosion occurred in a number of places on the helmet after immersion in salt water. The aluminum channel at the neck opening and the locking device which holds the face piece open were both corroded.

5. CONCLUSIONS

5.1 Conclusions

5.1.1 The hard shell is essentially satisfactory. Increased strength, especially bonding of the air ducts to the shell proper is desirable.

5.1.2 The method of attaching the suit top to the helmet is not satisfactory. The strength of the channel and locking ring is not satisfactory. The neck opening of the suit is too small.

5.1.3. The method of positioning and holding the helmet in place on the head is satisfactory.

5.1.4 The size and position of the oral-nasal mask is unsatisfactory. The seal obtained with the oral-nasal mask is unsatisfactory. The strengthening metal band is not of satisfactory shape.

5.1.5 The breathing resistance of the helmet is acceptable subjectively.

5.1.6 The buoyancy of the helmet is satisfactory.

5.1.7 The distribution of the weight of the helmet is not satisfactory. An undesirable torque is produced by the present distribution.

5.1.8 The helmet is compatible with communications systems.

5.1.9 The dump valve is unsatisfactory.

5.1.10 The time which would be required to remove the helmet in an emergency is unsatisfactorily long.

5.2 Recommendations

5.2.1 It is recommended that the following modifications be accomplished in the next phase of the development:

(1) Increase the strength of the hard shell.
(2) Improve the method of attaching the suit top to the helmet by:
  (a) Making the sealing operation easier to accomplish.
  (b) Increasing the size of the neck opening of the suit top.
  (c) Strengthening the rigid parts of the neck seal
(3) Provide a means of preventing or minimizing fogging of the face piece.
(4) Improve the fit, size and positioning of the oral-nasal mask to:
  (a) Improve the fit.
  (b) Eliminate the obstruction to vision.
  (c) Improve the comfort
(5) Modify the stiffener in the oral-nasal mask to eliminate discomfort.
(6) Distribute the weight of the helmet to eliminate torque.
(7) Modify the dump valve so that it can be used to dump water from the helmet with no possibility of water entering the helmet through the dump valve.
(8) Investigate the possibility of making the helmet easier to remove by the wearer in an emergency situation.
(9) Make all components of the helmet of non-corrosive materials.

5.2.2 The above recommendations should be accomplished while retaining all of the satisfactory features of the present helmet.

5.2.3 It is recommended that the helmet be made sufficiently large to fit the 95 percentile head size in order to determine whether or not this large size could be adapted internally to fit most of the head sizes encountered or whether a range of helmet sizes will be necessary.

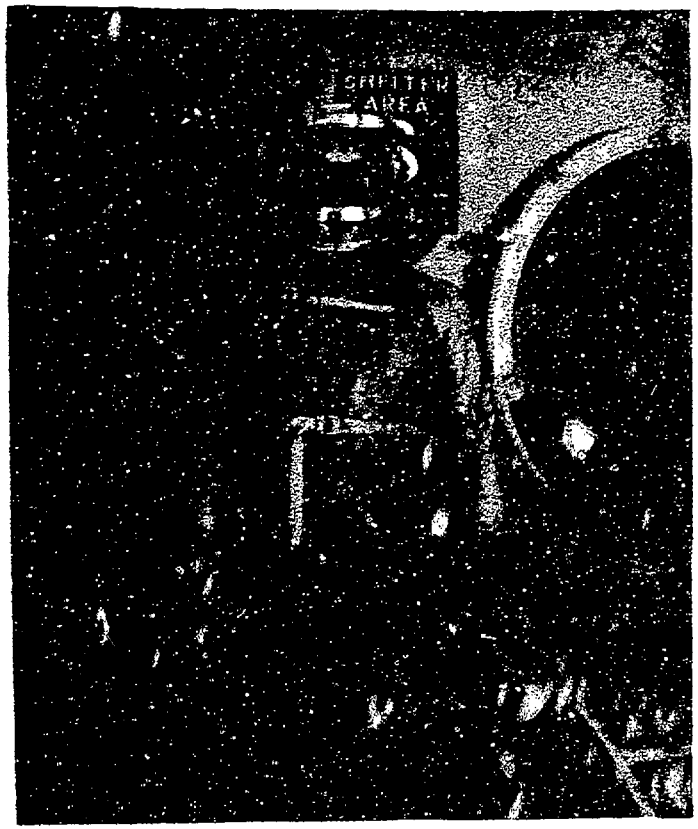

FIGURE 1 SWIMMERS HELMET AND SWIM SUIT – FRONT VIEW

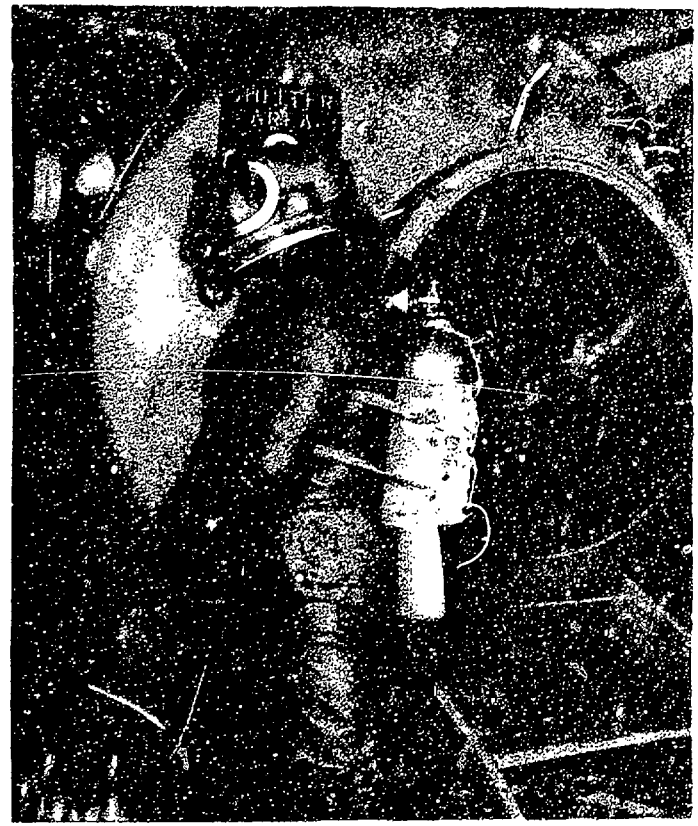

FIGURE 2 SWIMMERS HELMET AND SWIM SUIT – SIDE VIEW